

DRAGONFLIES AND DAMSELFLIES
OF MCKINNEY MARSH

A Thesis
Submitted to
the Department of Biology
Emporia Kansas State College

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by
M. Steve Cringan

May, 1977

Carl W. Prophet
Approved for Major Department

Lance E. Duest
Approved for Graduate Council

378462 6

ACKNOWLEDGMENTS

I wish to express my appreciation to Dr. Carl W. Prophet for his assistance and objective criticism in the preparation of this paper. Appreciation is also extended to Mr. and Mrs. J. C. McKinney for preserving a unique and diverse habitat and making it available for research. In addition I would like to express my appreciation to Dr. Thomas A. Eddy for an introduction to the Odonata, and Dr. James S. Wilson for an introduction to the taxonomy of flowering plants. For advice and verification of Odonates and other macroinvertebrates I would like to thank Don G. Huggins and personnel of the Kansas Biological Survey. I would also like to thank Don Seaton, Dennis Ronsse and Craig Dunn for companionship in the field and lab. Special thanks are extended to my sister, Sandra Brungardt, for typing this manuscript and to my wife, Nancy, for her understanding.

TABLE OF CONTENTS

	Page
INTRODUCTION.....	1
METHODS AND MATERIALS.....	4
DESCRIPTION OF AREA.....	7
Vegetation Characteristics.....	7
Physical Characteristics.....	7
RESULTS AND DISCUSSION.....	13
Adult Species Composition.....	13
Larval Species Composition.....	15
Adult Occurrence Periods.....	20
Oviposition Periods.....	24
Adult Relative Abundance.....	27
Associated Macroinvertebrates.....	29
SUMMARY.....	32
LITERATURE CITED.....	34

LIST OF TABLES

Table	Page
I. A species list of the common aquatic macrophytes observed at McKinney Marsh.....	10
II. A species list of adult odonates observed at McKinney Marsh and vicinity.....	14
III. A species list of larval odonates inhabiting McKinney Marsh.....	16
IV. A species list of adult odonates observed at McKinney Marsh.....	18
V. Occurrence periods of adult odonates observed at McKinney Marsh.....	21
VI. Oviposition periods of adult odonates observed at McKinney Marsh and vicinity.....	26
VII. Relative abundance of adult odonates based on median week of occurrence.....	28
VIII. A species list of associated macroinvertebrates inhabiting McKinney Marsh.....	30

LIST OF FIGURES

Figure	Page
1. Map of McKinney Marsh and vicinity.....	8
2. Fluctuation in surface area during study period.....	9
3. Distribution of dominant aquatic macrophytes at McKinney Marsh.....	11

INTRODUCTION

McKinney Marsh represents a unique aquatic situation for Lyon County, that of an extensive freshwater marsh. Freshwater marshes of this magnitude are considered uncommon in Kansas. The marsh was selected as a study site because of its apparent diversity of adult dragonflies and damselflies and for the opportunity to contribute to the knowledge of a relatively undisturbed habitat of a type that has often been overlooked in terms of odonates. Local interest has resulted in several previous and ongoing studies of the flora and fauna of the marsh (Weatherbolt, 1968; Schulenberg, 1974; Ronsse, 1977; Seaton, 1977).

Dragonflies and damselflies comprise one of the most widely recognized orders of aquatic Insecta, the Odonata. Most studies dealing with odonates have either involved single species life histories or species composition over large geographic areas (Grieve, 1937; Johnson, 1972a; Sawchyn and Gillott, 1974 and 1975). Results of numerous longterm investigations of the species composition of odonates of midwestern states have been published (Bick and Bick, 1957; Bick, 1959; Lawrence, 1967; Montgomery, 1967; Pruess, 1967; Bick and Hornuff, 1972 and 1974).

Information on the species composition of the odonates in Kansas is reasonably complete compared to other midwestern states. The first compilation of odonate species known to occur in Kansas was that of Kennedy (1917), who reported a

total of 63 species. Additions and confirmations to the species list were made by Allison (1921), Walker (1953), Needham and Westfall (1955), and Montgomery (1967); and recent efforts by personnel of the Kansas Biological Survey have expanded the list to 97 species (Huggins, et al., 1976).

Usually distributional studies provide little information other than the presence or absence of species. In the literature, reports of larval species composition for specific habitats are rare. Odonates are often wide ranging in flight; to identify the true species composition of a specific habitat necessitates the collection of larval forms as well as adults.

Benke and Benke (1975), in a life history study of the dragonfly population of Dick's pond in South Carolina, observed 19 species of adults. Occurrence periods were stated and positive associations were made between eight species of larvae and the corresponding adults. Bick and Bick (1958), during a study of odonates in Oklahoma, collected 24 species from four distinct, adjacent habitats, and compared the larval faunas of each of the four habitats to the adult faunas.

Few studies have been made on freshwater marshes. Kormondy and Gower (1965) described Twin pond, in Pennsylvania, as being heavily vegetated. Although it lacked the predominate emergent vegetation characteristic of a marsh, it did however bear much similarity with abundant submerged and

floating macrophytes. They reported 17 species of adult odonates.

Despite the obvious presence and abundance of odonate adults during the summer, relatively little information is available on the ecology of odonates in Kansas. Allison (1921) collected odonates within a 4 km radius of Pittsburg Kansas State College, resulting in an incomplete list of 34 species. The habitats sampled included three creeks, two strip pits, one pasture, and one lake. Occurrence periods and relative abundance were reported; however, only adults were collected with no species-habitat associations being made. Allison's study provides the only published information on the life histories of Kansas odonates.

The objectives of my study were: (1) to record adult-larval associations of odonate species inhabiting the marsh, (2) to determine periods of occurrence and oviposition, (3) to estimate relative abundance of adults, (4) to determine the associated aquatic macroinvertebrate fauna, and (5) to record annual variation in selected morphological and physicochemical features.

METHODS AND MATERIALS

Qualitative samples of adult and larval odonate populations were taken at weekly intervals, except for the period extending from November to March when they were taken at monthly intervals. The sampling period extended from 1 March 1975 through 8 October 1976. Field observations for occurrence and oviposition periods, as well as relative abundance of adults, were made during the weekly collecting trips.

Since the adult's flight is sometimes wide ranging, adjacent field and aquatic habitats were sampled in addition to the marsh. Adults were collected with aerial nets of 30 and 70 cm diameters.

Larvae were collected with a 15 cm² petite Ponar dredge, hand dip net, and artificial substrates. An abundance of roots and rhizomes restricted the use of the Ponar dredge to the few open areas in the marsh. Artificial substrates consisted of wire sterilizing baskets filled with vegetation, and they were used in both floating and submerged positions. The artificial substrates were generally colonized within one to two weeks; after this period they were removed to the laboratory to be picked and sorted. Low apparent odonate densities necessitated the collection of relatively large masses of vegetation, for this a hand dip net proved to be the most efficient method of collection.

Identification of odonate species from the larvae is not always possible. In many instances, adult odonates are

necessary before species identifications can be made. Identifications of odonates were based on Walker (1953), Needham and Westfall (1955), Gloyd (1958), Usinger (1968), Johnson and Westfall (1970), and Johnson (1972b). Both adult and larval identifications were verified by D. G. Huggins, aquatic biologist for the Kansas Biological Survey. Identifications of other macroinvertebrates were based on Pennak (1953), Ward and Whipple (1959), Usinger (1968), and Mason (1973), and were also verified by the Kansas Biological Survey.

To associate the larval population of the marsh to the adult population, some larvae were reared in the laboratory in several 4 liter aquaria to either final instar or adult stages. Midges, mayflies, and other soft-bodied macroinvertebrates collected in samples were used as food for the larvae.

Odonate larvae and other aquatic macroinvertebrates present in samples, were preserved in 70 per cent isopropyl alcohol. Adult reference specimens were placed in 7.5 by 15 cm glassine envelopes, with wings folded over the back and were then placed in file card cabinets with moth crystals. Representatives of most odonates and associated macroinvertebrates collected are maintained in the Aquatic Invertebrate Laboratory, Emporia Kansas State College. Selected odonate and macroinvertebrate specimens have been retained by the Kansas Biological Survey.

Selected physicochemical features were measured during

each collecting trip. Dissolved oxygen and temperature were measured with a YSI Model 51 oxygen meter; pH was measured in the laboratory with a Beckman Zeromatic II pH meter.

Data were stored on computer punch cards, in a format that allowed sorting on the basis of several assigned and observed parameters. An IBM card sorter and an IBM 407 accounting machine were used in processing data.

DESCRIPTION OF AREA

McKinney Marsh, locally known as "the marsh" is located 3 km south of Neosho Rapids in east central Lyon County. It is surrounded by several pools created by dredging for sand and gravel, this operation was abandoned more than 10 years ago (Fig. 1). Surface area of the marsh during normal rainfall is approximately 4.5 ha. Average depth is less than one meter, and low yearly water level generally occurs during spring (Fig. 2). Due to unusual rainfall pattern and low total rainfall, the marsh became completely dry during early September, 1976.

Vegetation Characteristics

The perimeter of the marsh is mostly open with only a few scattered trees and shrubs such as sandbar willow, Salix interior; buttonbush, Cephalanthus occidentalis; and common cottonwood, Populus deltoides. Aquatic vegetation is predominately emergent and floating, with little open water remaining after July (Table I and Fig. 3).

Physical Characteristics

The substrate in open areas is silt-clay, 15 to 20 cm deep, in vegetated areas the substrate is detritus-peat according to Environmental Protection Agency classification (Weber, 1973).

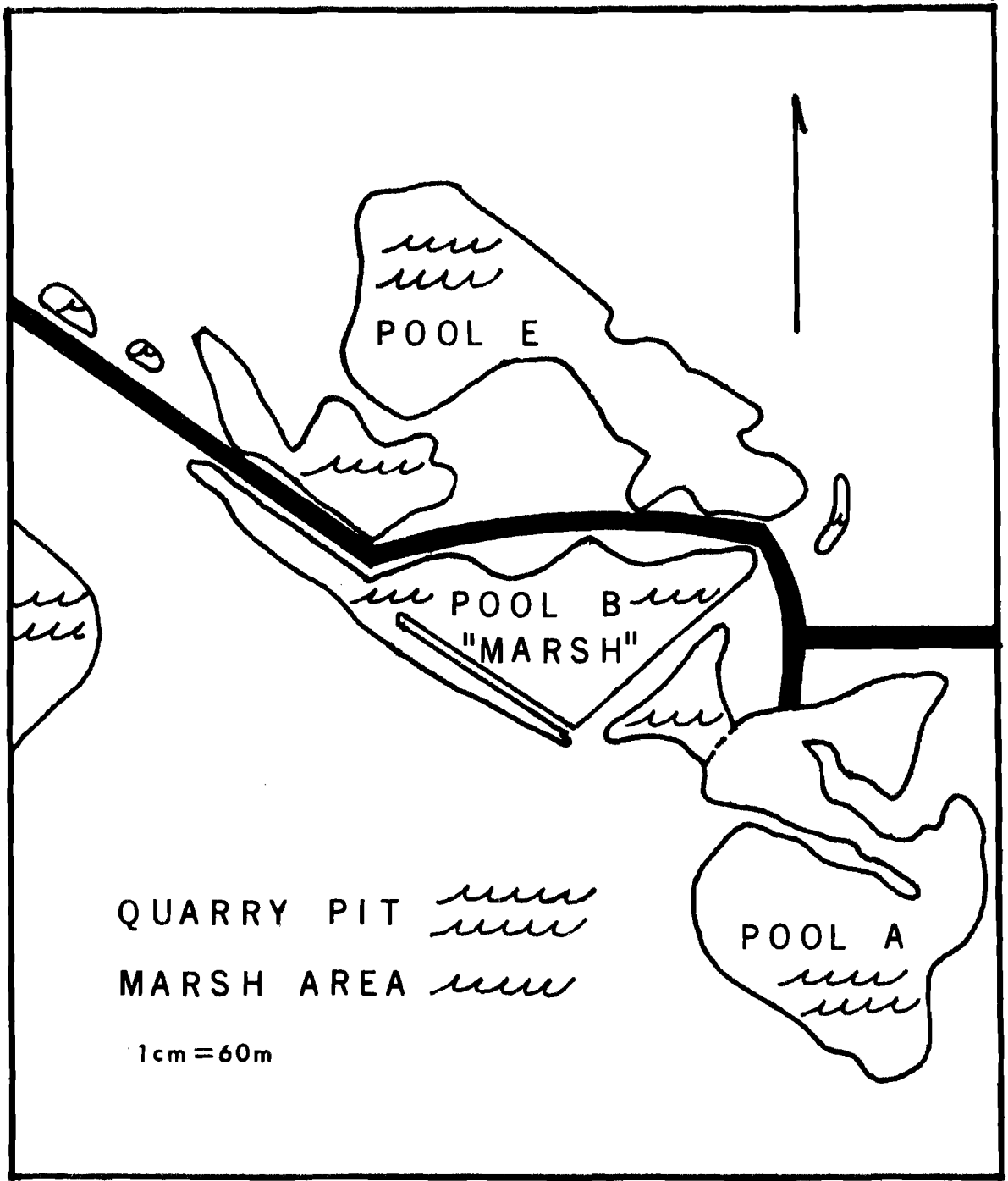


Fig. 1. Map of McKinney Marsh and vicinity.

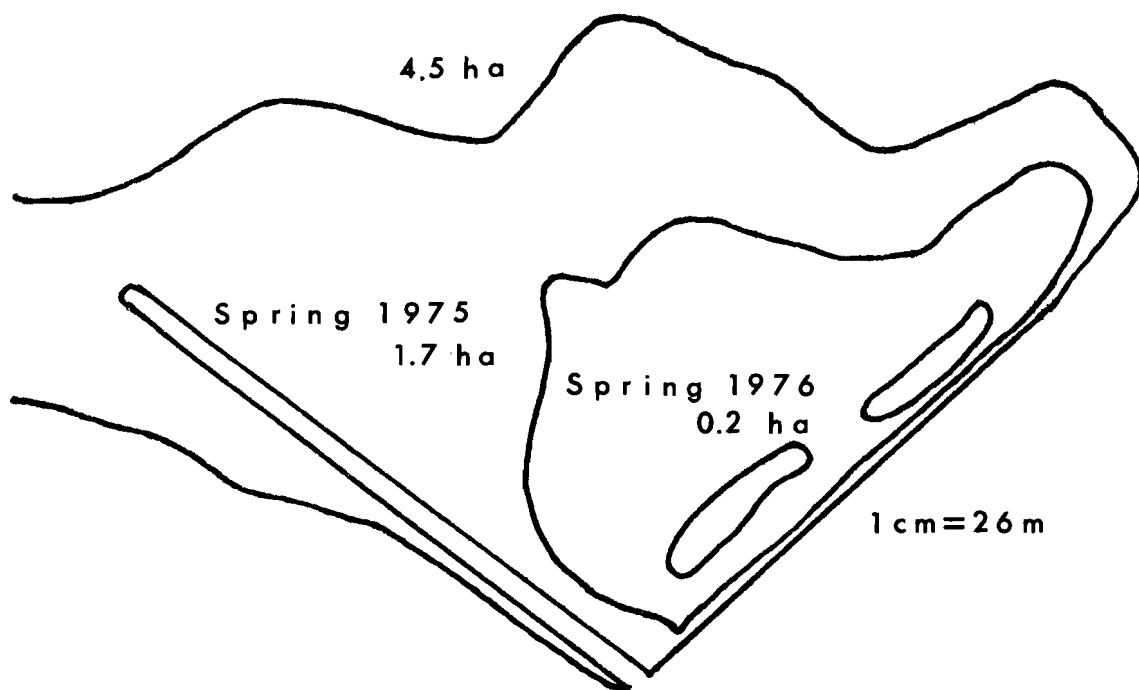


Fig. 2. Fluctuation in surface area during study period.

Table I. A species list of the common aquatic macrophytes observed at McKinney Marsh.

Species

Azolla caroliniana Willd.
Ceratophyllum demersum L.
C. echinatum Gray
Jussiaea repens L.
Lemna minor L.
Nelumbo lutea (Willd.) Per.
Polygonum bicornis Small.
P. coccineum Muhl.
P. lapathifolium L.
Pontederia cordata L.
Scirpus fluviatilis (Torr.) Gray
Sparganium eurycarpum Engelm.
Utricularia vulgaris L.

<u>Nelumbo lutea</u>	○
<u>Polygonum sp.</u>	▲
<u>Pontederia cordata</u>	■
<u>Scirpus fluviatilis</u>	△
<u>Sparganium eurycarpum</u>	◻
<u>Utricularia and Ceratophyllum</u>	×

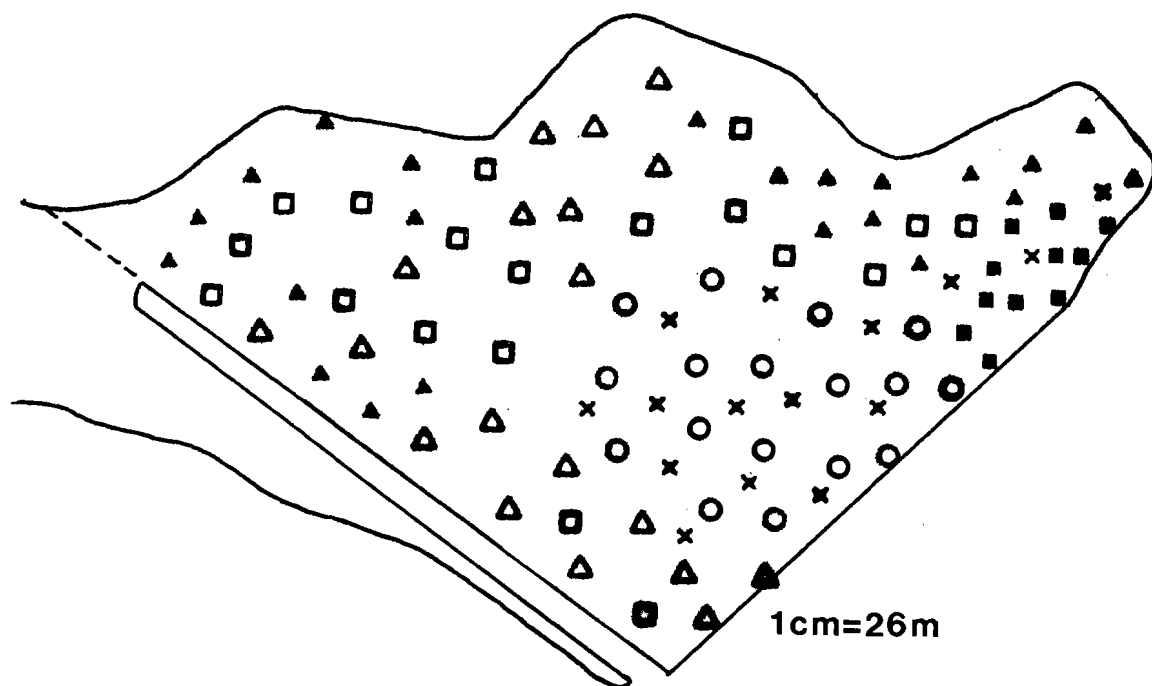


Fig. 3. Distribution of dominant aquatic macrophytes at McKinney Marsh.

During the study period pH of the water ranged from 6.3 to 7.4. When water temperature was 20 to 24 C, dissolved oxygen was typically in the range of 1 to 3 ppm. The annual range of dissolved oxygen was 0.0 to 14 ppm. Continual monitoring of dissolved oxygen over a 24 hr period during the summer revealed that concentrations decrease to less than 1 ppm overnight, throughout the water column.

RESULTS AND DISCUSSION

Adult Species Composition

McKinney Marsh was visited over 60 times between 1 March 1975 and 8 October 1976 resulting in over 240 man hours of field observation. A total of 28 species of odonates, representing six families, were identified from approximately 600 individuals collected.

Of the 28 species of odonates collected in the adult stage from the marsh and vicinity, all have been previously reported for the state (Table II). However three species, Anomalagrion hastatum, Lestes disjunctus australis, and Sympetrum internum, were of particular interest since they were just recently reported as new records for the state (Huggins, et al., 1976). The known distribution of each of the 28 species collected is scattered within the state and all of these species are known to occur in the eastern third of Kansas. Thus, none of the observations of this study constitutes a significant range extension for the observed species. Seven of the species, Dromogomphus spoliatus, Gomphus militaris, Celithemis epomina, Epitheca princeps, Pantala hymenea, S. internum, and Enallagma signatum, were apparently rare and were collected only during one season. Apparently the population densities of these species were low because few adults were observed or collected.

Little, or no information, is available on the odonate

Table II. A species list of adult odonates observed at McKinney Marsh and vicinity.

ANISOPTERA	ZYGOPTERA
Gomphidae	Lestidae
<u>Dromogomphus spoliatus</u>	<u>Lestes disjunctus australis</u>
<u>Gomphus militaris</u>	<u>L. rectangularis</u>
Aeschnidae	Coenagrionidae
<u>Aeschna constricta</u>	<u>Anomalagrion hastatum</u>
<u>Anax junius</u>	<u>Argia apicalis</u>
Cordulidae	<u>Enallagma basidens</u>
<u>Epitheca princeps</u>	<u>E. civile</u>
Libellulidae	<u>E. exulans</u>
<u>Celithemis epomina</u>	<u>E. signatum</u>
<u>Erythemis simplicicollis</u>	<u>Ishnura posita</u>
<u>Libellula luctuosa</u>	<u>I. verticalis</u>
<u>L. pulchella</u>	
<u>Pachydiplax longipennis</u>	
<u>Pantala flavescens</u>	
<u>P. hymenea</u>	
<u>Perithemis tenera</u>	
<u>Plathemis lydia</u>	
<u>Sympetrum corruptum</u>	
<u>S. internum</u>	
<u>S. vicinum</u>	
<u>Tramea lacerata</u>	

faunas of other freshwater marshes. Comparison of the species composition of the marsh to previous studies of other habitat types indicates a particularly diverse fauna for the marsh. Allison (1921) collected 34 species of odonates from seven separate habitats in southeast Kansas, over a period of three years; and Bick and Bick (1958) reported 24 species from four adjacent habitats in Oklahoma. However only 17 species were recorded at a small heavily vegetated pond in Pennsylvania (Kormondy and Gower, 1965).

Some studies of odonate populations in the southeastern states indicate a more diverse odonate fauna than that usually found in other areas of the United States. Benke and Benke (1975) collected a total of 19 species of dragonflies (Anisoptera) alone at a small pond in South Carolina. The fact that a comparable number of dragonfly species, 18, was found at the marsh supports the initial impression that the odonate fauna of this marsh is indeed diverse.

Larval Species Composition

At least eleven species of odonates were collected in the larval form (Table III). All were reared to adult or final instar except the larvae of Libellula. This taxon is probably L. luctuosa and not L. pulchella, since it was more abundant than L. pulchella in the adult stage. In addition, only L. luctuosa was observed ovipositing in the marsh. The larvae which were most frequently encountered and may be considered

Table III. A species list of larval odonates inhabiting McKinney Marsh.

ANISOPTERA	ZYGOPTERA
Aeschnidae	Lestidae
<u>Anax junius</u>	<u>Lestes rectangularis</u>
Libellulidae	Coenagrionidae
<u>Erythemis simplicicollis</u>	<u>Anomalagrion hastatum</u>
<u>Libellula sp.</u>	<u>Argia apicalis</u>
<u>Pachydiplax longipennis</u>	<u>Enallagma civile</u>
<u>Sympetrum vicinum</u>	<u>Ishnura posita</u>
	<u>I. verticalis</u>

the dominants were, Anax junius, Erythemis simplicicollis, Pachydiplax longipennis, and Ishnura verticalis.

Adult and larval species compositions in the marsh were not identical. Obviously, not all adults observed in the area utilized the marsh as a breeding habitat. There were additional nearby aquatic habitats, such as the sand and gravel pit pools, which could be utilized for breeding by certain species. Many of the 28 species of adults were either observed infrequently or not at all at the marsh proper (Table IV). Benke and Benke (1975) were able to obtain life history data on only eight species of larvae at a pond where 19 species of adults were present. Bick and Bick (1958) studied the adult and larval odonates associated with four distinct types of aquatic habitats in Oklahoma. In no single habitat could they find a larval stage for each species of adult observed at that habitat.

A number of explanations can be offered for this apparent difference in adult and larval species composition, and probably all have some validity. Species of the lowest densities as adults could easily be overlooked as larvae. It is generally recognized that coexisting congeneric species ensembles are comprised of a dominant and several rarer species (Istock, 1973). These rarer species would, of course, be of low population density and could be overlooked.

Congeneric species present as adults include Libellula luctuosa, L. pulchella, Pantala flavescens, P. hymenea,

Table IV. A species list of adult odonates observed at McKinney Marsh.

ANISOPTERA	ZYGOPTERA
Aeschnidae	Lestidae
<u>Anax junius</u>	<u>Lestes disjunctus australis</u>
Libellulidae	<u>L. rectangularis</u>
<u>Erythemis simplicicollis</u>	Coenagrionidae
<u>Libellula luctuosa</u>	<u>Anomalagrion hastatum</u>
<u>Pachydiplax longipennis</u>	<u>Argia apicalis</u>
<u>Perithemis tenera</u>	<u>Enallagma basidens</u>
<u>Sympetrum corruptum</u>	<u>E. civile</u>
<u>S. internum</u>	<u>E. exulans</u>
<u>S. vicinum</u>	<u>E. signatum</u>
	<u>Ishnura posita</u>
	<u>I. verticalis</u>

Sympetrum vicinum, S. internum, S. corruptum, Lestes rectangularis, L. disjunctus australis, Enallagma civile, E. basidens, E. exulans, E. signatum, Ishnura verticalis, and I. posita. Libellula pulchella, S. internum, S. corruptum, L. disjunctus australis, E. basidens, E. exulans, and E. signatum represent rarer species that may occur in the marsh in low density, but were not found.

Many aquatic insects display substrate preference. Although this was not specifically investigated in this study, it may be a factor determining the larval species composition of the marsh. This marsh has a clay-silt and detritus-peat substrate with considerable vegetation. Pool A has a gravelly substrate and larvae of Dromogomphus spoliatus are numerous (Fig. 1). Exuvia of Tramea lacerata were found in Pool E which has a sand substrate.

Oxygen tolerance, for which there is little information available on odonates, may also be a factor restricting the species composition of the marsh. Through July, August, and September, dissolved oxygen is usually in the range of 1 to 3 ppm, with depletion overnight. Gaufin, et al., (1974) investigated oxygen tolerance of several species of aquatic insects in the northwestern portion of the United States. His data demonstrate that extended exposure to oxygen concentrations of 1 to 5 ppm can be lethal to many types of aquatic organisms including odonates. The dissolved oxygen characteristics of the marsh may have considerable influence on

habitat selection and survival of larval odonates.

Adult Occurrence Periods

Occurrence periods were determined from first and last observation, or collection, of each species, during two years (Table V). Six species, Dromogomphus spoliatus, Gomphus militaris, Epithea princeps, Pantala hymenea, Sympetrum internum, and Enallagma signatum, were represented by a single collection.

Corbet (1954), in a study of British dragonflies described what he referred to as spring and summer species. Spring species overwinter as late instar larvae and emerge synchronously within a relatively short time in the spring. Summer species overwinter as early instar larvae and emerge asynchronously throughout the summer, after development has taken place. His interpretation has been supported by other studies at northern latitudes and high altitudes (Sawchyn and Gillott, 1974 and 1975). The data of Paulson and Jenner (1971) do not support the interpretation of Corbet. They observed that the life histories of odonates in North Carolina did not fit the two categories of spring and summer species, but instead were composed of a wide variety of less distinct emergence patterns. The same conditions were observed in this study. Anax junius, Erythemis simplicicollis, Libellula luctuosa, Pachydiplax longipennis, Lestes rectangularis, Ishnura posita, and I. verticalis all

Table V. Occurrence periods of adult odonates observed at McKinney Marsh.

Species	April	May	June	July	Aug.	Sept.	Oct.
<u>Dromogomphus spoliatus*</u>							
<u>Gomphus militaris</u>							
<u>Aeschna constricta</u>						█	
<u>Anax junius</u>		█	█	█	█	█	█
<u>Epitheca princeps*</u>							
<u>Celithemis epomina*</u>					█		
<u>Erythemis simplicicollis</u>			█	█	█	█	
<u>Libellula luctuosa</u>		█	█	█	█	█	
<u>L. pulchella</u>			█	█	█		
<u>Pachydiplax longipennis</u>		█	█	█	█	█	
<u>Pantala flavescens</u>				█	█	█	
<u>P. hymenea*</u>							
<u>Perithemis tenera</u>				█	█	█	

Table V. (continued)

Species	April	May	June	July	Aug.	Sept.	Oct.
<u>Plathemis lydia</u>					██████████		
<u>Sympetrum corruptum</u> *						██████████	
<u>S. internum</u> *							
<u>S. vicinum</u>				██████████	██████████	██████████	
<u>Tramea lacerata</u>				██████████	██████████		
<u>Lestes disjunctus australis</u>			██████████				
<u>L. rectangularis</u>		██████████	██████████	██████████			
<u>Anomalagrion hastatum</u> *				██████████			
<u>Argia apicalis</u>			██████████	██████████			
<u>Enallagma basidens</u> *			██████████	██████████			
<u>E. civile</u>			██████████	██████████	██████████	██████████	
<u>E. exulans</u> *			██████████	██████████			
<u>E. signatum</u> *							

Table V. (continued)

Species	April	May	June	July	Aug.	Sept.	Oct.
<u>Ishnura posita</u>		[REDACTED]					
<u>I. verticalis</u>		[REDACTED]					

*Species infrequently observed

had relatively long occurrence periods indicating asynchronous emergence; however, many of these same species started emerging in early spring, a characteristic of spring species. Aeschna constricta, Celithemis epomina, Sympetrum corruptum, Anomalagrion hastatum, Argia apicalis, Enallagma basidens, and E. exulans all had short occurrence periods of less than two months, this indicates a degree of synchrony in emergence. However, all of these species began emerging later than June 1, and two species, A. constricta and S. corruptum, did not emerge until mid-September. Obviously, clear cut synchronous-asynchronous or spring-summer emergence patterns are not characteristic of Kansas species, and additional study will be necessary before emergence patterns for all species can be determined. Occurrence periods may also vary with annual climatic conditions.

Comparison of these data to previous data collected over a like period of time from a different habitat provides little additional information. Allison (1921) reported occurrence periods for 15 of the species observed at the marsh; his observations were made in southeastern Kansas. The durations were similar; but in general, my results indicated emergence beginning two to three weeks earlier.

Oviposition Periods

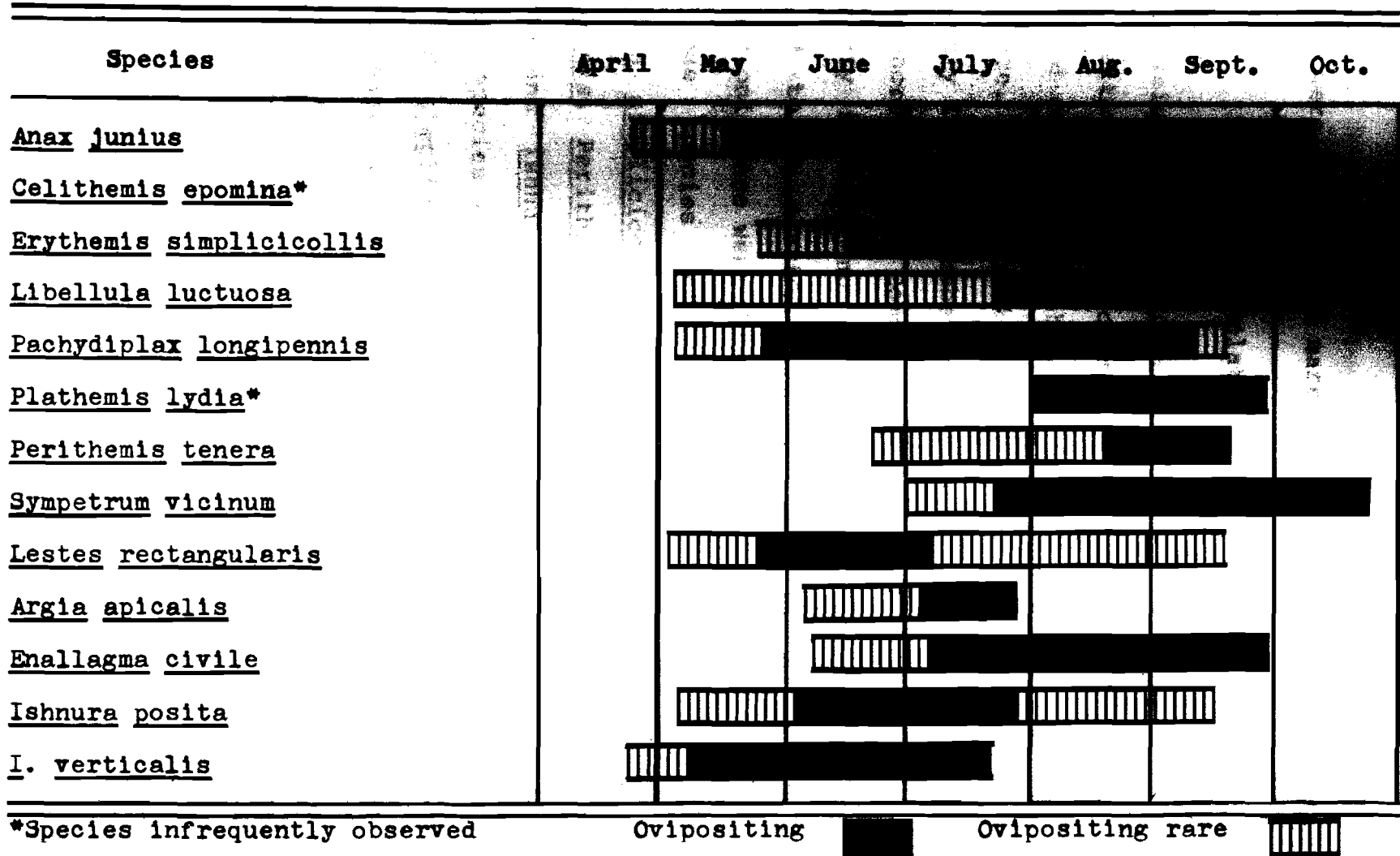
Oviposition periods are reported as a portion of the occurrence period when the majority of the population was

ovipositing (Table VI). These periods are subject to annual variation in occurrence. Data are provided for the 13 species frequently observed. Two of the species Celithemis epomina and Plathemis lydia were not observed ovipositing in the marsh.

The lag in oviposition as compared to occurrence is the approximate length of time required for sexual maturation. Gower and Kormondy (1963) reported that sexual maturation in Lestes rectangularis took 21 to 24 days, my data indicate 20 days. In some species the males mature faster than the females. The males remain at the water to establish territories while the females fly away from the water and return after sexual maturity (Corbet, 1957; Sawchyn and Gillott, 1974). Sexual maturation usually takes from two to four weeks. Where the observed lag was more than two to four weeks, as in Libellula luctuosa and Perithemis tenera, low early emergence densities may have resulted in inadequate observations.

In most cases oviposition continued within a population until its seasonal occurrence ended. In the case of L. rectangularis and Ishnura posita a gradual decrease in the population density made adequate observations impossible. Logically, larvae are most abundant in September and October, after oviposition has ended for most species and before mortality has become significant. Libellula sp., Sympetrum vicinum, L. rectangularis, Anomalagrion hastatum, and Argia

Table VI. Oviposition periods of odonates observed at McKinney Marsh and vicinity.



apicalis were found in the marsh as larvae only at this time.

Adult Relative Abundance

Relative abundance is reported as an arbitrary assignment of either abundant, common, uncommon or rare. Estimates are based on notes of abundance during the median week of occurrence. Species considered abundant were those observed frequently in large numbers (more than one individual per 10 m of shoreline). Common species were those observed frequently in fewer numbers. Uncommon species were those observed to be scattered and in low numbers. Species observed only once were designated as rare (Table VII).

Those species reported as abundant, Anax junius, Erythemis simplicicollis, Libellula luctuosa, Pachydiplax longipennis, Perithemis tenera, Argia apicalis, Enallagma civile, and Ishnura verticalis, may be considered the dominant species as adults. Four of the same species A. junius, E. simplicicollis, P. longipennis, and I. verticalis were dominant as larvae.

The six congeneric species ensembles are each composed of one member that is abundant or common while the other members are uncommon or rare. L. luctuosa, Pantala flavescens, Sympetrum vicinum, Lestes rectangularis, E. civile, and I. verticalis were either abundant or common. L. pulchella, P. hymenea, S. internum, S. corruptum, L. disjunctus australis, E. basidens, E. exulans, E. signatum,

Table VII. Relative abundance of adult odonates based on median week of occurrence.

ANISOPTERA	ABUNDANCE	ZYGOPTERA	ABUNDANCE
Gomphidae		Lestidae	
<u>Dromogomphus spoliatus</u>	R	<u>Lestes rectangularis</u>	C
<u>Gomphus militaris</u>	R	<u>L. disjunctus australis</u>	U
Aeschnidae		Coenagrionidae	
<u>Aeschna constricta</u>	U	<u>Anomalagrion hastatum</u>	U
<u>Anax junius</u>	A	<u>Argia apicalis</u>	A
		<u>Enallagma basidens</u>	U
Cordulidae		<u>E. civile</u>	A
		<u>E. exulans</u>	U
<u>Epitheca princeps</u>	R	<u>E. signatum</u>	R
		<u>Ishnura posita</u>	C
Libellulidae		<u>I. verticalis</u>	A
<u>Celithemis epomina</u>	U		
<u>Erythemis simplicicollis</u>	A		
<u>Libellula luctuosa</u>	A		
<u>L. pulchella</u>	U		
<u>Pachydiplax longipennis</u>	A		
<u>Pantala flavescens</u>	C		
<u>P. hymenea</u>	R		
<u>Perithemis tenera</u>	A		
<u>Plathemis lydia</u>	C		
<u>Sympetrum corruptum</u>	U		
<u>S. internum</u>	R		
<u>S. vicinum</u>	C		
<u>Tramea lacerata</u>	C		

Abundant A Common C Uncommon U Rare R

and Ishnura posita were either uncommon or rare.

Associated Macroinvertebrates

Sixty-two taxa of aquatic macroinvertebrates were found in association with the 11 species of odonate larvae inhabiting the marsh (Table VIII). The Coleoptera formed the largest group, with 20 species present. This should be considered a partial list of macroinvertebrates, since odonates were the group of emphasis.

Table VIII. A species list of associated macroinvertebrates inhabiting McKinney Marsh.

TAXA	TAXA
PORIFERA	AMPHIPODA
Porifera	<u>Hyalella azteca</u>
ROTARIA	DECAPODA
<u>Sinantherina</u>	<u>Procambarus gracilis</u>
NEMATODA	COLLEMBOLA
Nematoda	<u>Isotomurus palustris</u> <u>Podura aquatica</u>
ANNELIDA	EPHEMEROPTERA
<u>Limnodrilus</u> <u>Tubifex tubifex</u> Hirudinea	<u>Baetis</u> <u>Caenis</u>
MOLLUSKA	HEMIPTERA
<u>Heliosoma trivolis lentum</u> <u>Physa anatina</u> <u>Promentus exacuouus</u> <u>P. umbilicatus</u> <u>Sphaerium M. transversum</u>	<u>Merragata hebroides</u> <u>Sigara</u> <u>Notonecta undulata</u> <u>Bueno scimirra</u> <u>Belostoma fumineum</u> <u>Gerris marginata</u> <u>Hydrometra martini</u> <u>Ranatra</u> <u>Neoplea striola</u>
ARACHNIDA	MEGALOPTERA
Pisauridae Hydracarina	<u>Chauloides rastricornus</u>
CONCHOSTRACA	COLEOPTERA
<u>Caenestheriella belfragei</u>	<u>Helophorus</u> <u>Tropisternis</u> <u>Berosus</u> <u>Helochares</u>
ISOPODA	
<u>Asellus</u>	

Table VII (continued)

	TAXA
	DIPTERA
<u>Hydrochara</u>	<u>Chaeoberous</u>
<u>Dineutus</u>	<u>Chironomus</u>
<u>Peltodytes</u>	<u>Parachironomus</u>
<u>Halipus</u>	<u>Procladius</u>
<u>Hydrovatus</u>	<u>Ablabesmyia</u>
<u>Ilybius</u>	<u>Tanypus</u>
<u>Coptotomus</u>	<u>Clinotanypus</u>
<u>Agabus</u>	<u>Tipula</u>
<u>Hydroporus</u>	<u>Tabanus</u>
<u>Cybister</u>	<u>Sepedon</u>
<u>Hydaticus</u>	<u>Ceratopogonidae</u>
<u>Hydrocanthus</u>	
<u>Phytonomus</u>	
<u>Pontomalota</u>	
<u>Scarabeidae</u>	
<u>Carabidae</u>	

SUMMARY

1) Life history data were collected on the odonate population inhabiting McKinney Marsh and vicinity, between 1 March 1975 and 8 October 1976. Over 240 hr of field observations were made.

2) Twenty-eight species of adult odonates were observed. Comparison to previous studies in similar climates indicates that the marsh has a particularly diverse odonate fauna. Seven species, Dromogomphus spoliatus, Gomphus militaris, Celithemis epomina, Epitheca princeps, Pantala hymenea, Sympetrum internum and Enallagma signatum were collected only once or rarely.

3) Eleven species were observed inhabiting the marsh in the larval stage. The dominant larvae present were Anax junius, Erythemis simplicicollis, Pachydiplax longipennis, and Ishnura verticalis. In many cases the larvae were reared to final instar or adult stages in order to identify them.

4) Occurrence periods were reported for all species collected as adults. Data indicate a wide variety of emergence patterns. The longest occurrence period for a single species was that of A. junius, over 160 days.

5) Oviposition periods were reported as a portion of the occurrence period when the majority of the population was ovipositing. Oviposition periods were reported for 13 species. The greatest larval odonate densities occurred during October and September after ovipositing was complete.

6) Relative abundance of adults was estimated from the median week of occurrence. Species reported as abundant, Anax junius, Erythemis simplicicollis, Libellula luctuosa, Pachydiplax longipennis, Perithemis tenera, Argia apicalis, Enallagma civile, and Ishnura verticalis, may be considered dominant as adults. Six congeneric species ensembles were observed, each composed of one member that was abundant or common while the remaining members were either uncommon or rare. The congeneric ensembles were composed of the genera; Libellula, Pantala, Sympetrum, Lestes, Enallagma, and Ishnura.

7) Sixty-two taxa of aquatic macroinvertebrates, dominated by the Coleoptera, were found in association with the 11 species of odonate larvae.

LITERATURE CITED

LITERATURE CITED

- Allison, J. L. 1957. Some dragonflies of southeastern Kansas. *Kans. Acad. Sci.* 30:45-48.
- Benke, S. Benke. 1975. Comparative dynamics of coexisting dragonfly populations. *Ecology* 56:307-317.
- Bickel, C. Bick. 1957. The Odonata of Oklahoma. *Great Basin Nat.* 2:1-18.
- _____. 1958. The ecology of the dragonfly fauna of a small creek in southern Oklahoma. *Tenn. J. Sci.* 19:240-251.
- Bickel, C. Bick. 1959. Additional dragonflies from Arkansas. *Great Basin Nat.* 4:131-142.
- Bickel, C. Bick, and L. E. Hornuff. 1972. Odonata collected in North Dakota, and Nebraska. *Proc. Entmol. Soc. Am.* 74:1-8.
- _____. 1974. New records of dragonflies from Montana and Colorado. *Proc. Entmol. Soc. Am.* 76:90-93.
- Corbet, A. W. 1954. Seasonal regulation in British dragonflies. *Nature* 174:655-777.
- Corbet, A. W. 1957. The life history of the emperor dragonfly Anax imperator Leach. *J. Anim. Ecology* 26:1-12.
- Gaufin, J. R., and R. Clubb and R. Newell. 1974. Studies on tolerance of aquatic insects to low oxygen concentrations. *Great Basin Nat.* 34:45-59.
- Gloyd, E. E. 1958. The dragonfly fauna of the Big Bend region of Trans-Pecos Texas. *Occas. Papers Mus. Zoo., Univ. Mich.* No. 593.
- Gower, J. L., and E. J. Kormondy. 1963. Life history of the damselfly Lestes rectangularis with special reference to seasonal regulation. *Ecology* 44:398-402.
- Grieve, E. G. 1937. Studies on the biology of the damselfly Ishnura verticalis Say, with notes on certain parasites. *Entomologica Americana* 17:121-153.

- H... P. M. Liechti and D. W. Roubik. 1976. ... counts for certain aquatic macroinvertebrates ... (Odonata, Hemiptera, Coleoptera, and ...). Tech. Publ. State Bio. Survey, Kansas. No. ...
- I... 1973. Population characteristics of a species of waterboatmen (Corixidae). *Ecology* 54:535-...
- J... 1972a. An analysis of geographical variation in ... fly, Argia apicalis. *Can. Ent.* 104:1515-...
- ... 1972b. The damselflies of Texas. *Bull. State Museum, Biol. Sci.* 16:55-128.
- J... and M. J. Westfall, Jr. 1970. Diagnostic keys ... on the damselflies of Florida. *Bull. Florida Museum, Biol. Sci.* 15:45-89.
- K... 1917. The Odonata of Kansas with reference to ... distribution. *Univ. Kansas, dept. Ent. Bull.* ... 45.
- K... J., and J. L. Gower. 1965. Life history ... in an association of Odonata. *Ecology* ... 86.
- L... M. 1967. The distribution of Odonata in Indiana ... Proc. North Central Branch Ent. Soc. Amer. ... 120.
- M... 1973. An introduction to the identification of ... mid larvae. Analytical Quality Control Lab., ... Environmental Protection Agency, Cinc., Ohio.
- Mont... B. E. 1967. Geographical distribution of the ... of the North Central States. *Proc. North Central Branch Ent. Soc. Amer.* 22:121-129.
- Needh... G., and M. J. Westfall, Jr. 1955. A manual of ... gonflies of North America (Anisoptera). Univ. California Press, Berkeley and Los Angeles, 615 p.
- Paul... R., and C. E. Jenner. 1971. Population ... in overwintering larval Odonata in North ... in relation to adult flight season. *Ecology* ... 107.

- W. 1953. Freshwater invertebrates of the United States. Ronald Press Company, New York. 769 p.
- C. 1967. Checklist of Nebraska Odonata. Proc. Central Branch Ent. Soc. Amer. 22:112.
1977. Flora of McKinney Marsh. Unpublished Masters Thesis. Emporia Kansas State College.
- W., and C. Gillott. 1974. The life histories of several species of Lestes in Saskatchewan. Can. Ent. 107:1183-1293.
1975. The biology of two undescribed species of coenagrionid dragonflies in western Canada. Can. Ent. 107:119-128
- Schroeder, J. 1974. Area bird observation notes. Kansas Ornithological Soc., Newsletter. 2:2.
1977. Algae of McKinney Marsh. Unpublished Masters Thesis. Emporia Kansas State College.
- Usher, R. L. 1968. Aquatic Insects of California. Univ. California Press, Toronto. 690 p.
- Walker, E. M. 1953. The Odonata of Canada and Alaska. Univ. Toronto Press, Toronto. 292 p.
- Ward, R. B., and G. C. Whipple. 1959. Freshwater biology. 2nd. Ed. John Wiley and Sons, Inc. N.Y.
- Weatherbolt, R. 1968. An annotated checklist of the flowering plants of Lyon County, Kansas. Unpublished Masters Research Problem. Emporia Kansas State College.
- Weber, C. I. 1973. Biological field and laboratory methods. Environmental Monitoring Series, U. S. Environmental Protection Agency. Cincinnati, Ohio.